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CONTENTS

	Page
Editorial	ii
The Role of Forestry in Food Security	1
Comet Halley: A Brief History of the Object and What to Expect in the Coming Months	12
Introducing Factor Analysis in Geography	18
Central Place Theory and its Application in Zimbabwe	26
A Study of Perceptions of Different Residential Areas of Harare	49
Student Dissertations in the Geography Department at the University of Zimbabwe	71
Book Review	84

THE ROLE OF FORESTRY IN FOOD SECURITY

Committee on World Food Security Food and Agricultural Organisation of the United Nations

I. INTRODUCTION

Land use practices that lead to environmental degradation are widely recognized as a principal cause of the food emergencies that occur with such tragic frequency in developing countries. It is also well known that they have put the long-term future of food supplies in jeopardy. Nevertheless, they have so far received little attention in international discussions of world food security.

It is therefore opportune that the Twenty-second Session of the FAO Conference in November 1983 expressed its concern at the threat to the base for continued food production from excessive deforestation (1), and that the Seventh Session of the FAO Committee on Forestry (COFO) in May 1984 recommended that FAO prepare a study on the interrelationship between forestry and food security and that this should be brought to the attention of the CFS (2). The Eighty-sixth Session of the FAO Council in November 1984 endorsed this recommendation (3).

This document has been prepared by FAO's Forestry Department in response to the COFO and Council recommendations. Although it is mainly concerned with the fundamental contribution of forestry to environmental stability, it also makes a preliminary survey of the many other roles of forestry in food security.

Forestry contributes to each of the three main goals of world food security identified by the CFS. It increases the adequacy of food supplies in direct as well as indirect ways. It makes for greater stability in these supplies both in its overall protective environmental role and at the farm level. It also contributes to access to adequate food supplies through the generation of rural employment and income and of foreign exchange earnings. There is finally its special and less easily classifiable role of supplying fuelwood for food preservation and preparation.

The document begins with an account of the fundamental role of forestry in maintaining the soil and water base for food production. It goes on to deal with other direct and indirect contributions of forest resources to food security. It then looks at the important role of trees in farming systems.

II. MAINTAINING THE SOIL AND WATER BASE

The most obvious of the links between food production and forests is the continued transfer of land from forest to agricultural use. Much of the world's agricultural land was formerly under forest vegetation. It is estimated by FAO that in the tropics 7.5 million ha of closed forest and 3.8 million ha of more open woodland are currently cleared each year, almost entirely for agriculture (4).

There is no doubt that further forest land will be cleared for agriculture. However, much of the land that is cleared is not suitable for permanent agriculture, and is likely to become rapidly degraded or eroded. Such land serves a more useful productive function under forest cover which maintains the soil and water base. It is therefore encouraging that FAO's proposals on how agricultural production should be increased up to the end of this century call for only about a quarter of the increase in crop production to come from the extension of the arable area (5), with the remaining increase coming from improved productivity.

Forest vegetation and its accompanying soil organisms probably make up as much as 90 percent of the total biomass on land, and thus represent a physically immense foundation for ecological stability. However, human beings have already vastly weakened this asset by deforestation, and the stability of many ecological systems has therefore been greatly disturbed.

The relation of forests and environmental stability is complex and not yet fully understood. What is certain is that they can help to even out the run-off of whatever rain does fall, and thereby avoid extremes of soil inundation and desiccation. At the local level, the presence of forest areas has a moderating effect on extremes of temperature and air humidity on neighbouring agricultural land.

Three specific situations in which forest cover plays a critical role in maintaining the soil and water base for food production are in upland watersheds, arid lands and tropical forest soils, and these cases are therefore discussed separately below.

Upland watersheds

Excessive deforestation of mountain land not only causes soil erosion on the cleared land but is also, because of its effects on the water regime, a major threat to agriculture in the areas situated downstream. Torrential rivers carry away soil in vast quantities, destroy bridges and buildings, flood fields, disturb fisheries, and deposit silt in reservoirs and irrigation channels, thus greatly reducing the useful life of these costly installations. Deforestation can even cause droughts as well as floods downstream, as a result of a less regular flow of water. The massive flood damage to food production in the plain areas of South Asia is only one example of the consequences of excessive deforestation in upland watershed areas.

To protect agriculture from such disasters, the integrated management of whole watersheds is essential. The conservation of existing forests, together with strategically located reforestation, is a key aspect of protecting the soil in the upper parts of a catchment area and of limiting downstream damage. The presence of trees breaks the force of heavy rainfall, thus facilitating its absorption into the soil, reducing surface run-off, and moderating and regulating stream flow. Although this may reduce the quantity of water available to irrigation schemes fed from the hills, the improved quality of the water and its more regular flow should usually compensate by saving reservoirs and channels from rapid siltation.

In addition to forest conservation and reforestation, the maintenance and rehabilitation of watersheds requires the construction of physical works to control erosion and flooding. It is necessary to recognize that many people are already living in these areas as farmers, and to introduce

programmes that are acceptable to them to minimize damage to the forest resource from harmful cultivation and grazing practices. As is discussed later in this document, trees are an essential component of many of the improved farming systems that are required. Examples of successful watershed rehabilitation, embodying all these aspects, include a number of recent projects in India and Nepal.

Arid and semi-arid lands

In arid and semi-arid areas, wind rather than water is the main agent of erosion. The maintenance of woodland areas reduces the removal of dust and sand from badly eroded land, and the presence of trees between these areas and agricultural land can moderate the effects of dust storms and sand-dune formation. Woody vegetation, with its shade and deep roots, also stays green when grasslands have dried up. It can thus provide important reserves of livestock feed for the dry season and in drought years. The seasonal importance of arboreal fodder is particularly great in the Sahelian zone of Africa.

Tree components in land use in arid areas (e.g. shelterbelts, windbreaks) help to combat drought and desertification through improved biological productivity and plant biomass, higher carrying capacity for livestock, better crop yields from soil conservation, reduction of wind erosion, sand-dune fixation and the amelioration of microclimates, and the protection of human habitats and infrastructure. Trees can also be used to rehabilitate salt-affected land and sand-dunes, through their ability to tap moisture and nutrients in the deeper soil layers.

Excessive deforestation, together with overgrazing and the cultivation of marginal land, can greatly worsen the effects on food production of periods of low rainfall or drought. It is also a major cause of desertification. In addition to the 6 percent of the world's land area that is already extreme desert, a further 29 percent has been classified as subject to varying degrees of desertification hazard (6).

Government programmes to control desertification are increasingly based on the greater incorporation of trees in farming systems, which is discussed in a later part of this document. They also include major afforestation schemes, such as China's "Great Green Wall" of about 6 000 km in length round the borders of the Gobi desert.

Forest soils of the humid tropics

Many forest soils of the humid tropics are of low fertility and poor structure and are difficult to keep in continuous cultivation. Their principal present use for agriculture is under the various systems of shifting cultivation, relying on a long period of fallow for the restoration of fertility, which are still the most widespread farming systems in the tropics. It is estimated that the fallow areas associated with shifting cultivation occupy some 410 million ha, or more than 20 percent of the existing area of tropical forest (7). Part of this area is in the fragile upland watersheds discussed above.

The natural regeneration of woody vegetation during the fallow period of shifting cultivation includes many species with deep roots that can draw on sources of plant nutrients inaccessible to crop plants. These nutrients

are drawn into their leaves, which end up scattered on the surface and incorporated in the soil layers that can be exploited by crop plants.

Provided the fallow period is long enough, traditional systems of shifting cultivation are in ecological balance with the environment and do not irreversibly degrade the soil resource. However, increasing population pressure has led to longer cropping periods and to shorter fallows that are no longer adequate to restore fertility. When the natural cycle of regeneration is broken in this way, crop yields fall sharply and rapid soil degradation sets in.

In the past, government programmes were often aimed at abolishing shifting cultivation, but the main emphasis now is on its amelioration. The problems of changing from shifting cultivation to more permanent systems are very complex, especially because the cultivators, impoverished still further by declining yields, cannot afford the improvements required to maintain fertility and prevent degradation. Many different permanent systems have been proposed as an alternative to shifting cultivation and are the subject of a substantial amount of research (8). Several of the more promising of the proposed solutions involve some combination of forest or other trees with crops and livestock, and will be discussed later in connection with the role of trees in farming systems.

III. OTHER FORESTRY CONTRIBUTIONS TO FOOD SECURITY

Although by far the greatest contribution of forestry to food security is through its protective environmental role outlined above, forestry proper (as opposed to the use of trees in farming systems) also contributes in a number of other ways. Naturally occurring foods from the forest (including wildlife) are much more important than is generally realized in the food supplies of many countries. Forestry also contributes to the access to adequate food supplies as a source of rural employment and income and of foreign exchange earnings. There are also cases where forest roads and other infrastructure assist in opening up remote areas for food production. Finally there is the special and urgent question of fuelwood supplies.

Food from the forest

Some wild forest plants provide staple foods, such as the sago palm of southeast Asia. More generally they provide nutritionally valuable supplements to diets based on one or a few staples. They may be available when other foods are short, thus contributing to the stability of food supplies throughout the year. Plant foods from the forest include many different fruits, nuts, leaves, roots and fungi. Some are also important sources of income, such as the palm hearts of which Brazil produces from 20 to 30 000 tons a year. Honey is another significant source of food and income from the forest.

Forest trees and plants also provide fodder for livestock, which is often available when grassland has dried out. Suitable shoots, foliage and fruits can be gathered or the animals can browse directly in the forest, although the latter requires careful regulation of the numbers and movement of grazing animals if the forest resource is not to be destroyed. With wide spacing, high pruning and the sowing of nutritious ground cover (for example, elephant grass), it is also possible to improve the fodder yield of forest plantations.

Probably, however, wildlife is the biggest source of food directly available from the forest. In many areas wildlife, including small rodents, reptiles, birds, snails and insects as well as larger species, makes up a very large part of animal protein supplies, for example as much as 60 percent in Botswana, 70 percent in Liberia and 75 percent in Ghana.

In some situations, such as the savanna (open woodland) areas of Africa, the larger mammalian species of wildlife are superior to domestic livestock because of their more efficient conversion of vegetation to meat, their better ecological adaptation, and their more limited management requirements (including disease protection). Much attention has therefore been given recently to methods of exploiting them more effectively through such methods as game cropping and ranching.

As regards both wildlife and potential food plants, the world's forests constitute its largest reserve of genetic diversity, including the wild relatives of important staple food plants. The surest method of conserving this irreplaceable pool of genetic material is the conservation of the forest habitats themselves.

Employment and income

Forestry and the industrial and artisanal activities based on it are significant sources of rural employment and income. Forest management operations, including planting, weeding, thinning, pruning, felling, logging and road building, lend themselves to the use of labour-intensive technology. With such technology there can be about 25 full-time jobs per 1 000 ha of intensively managed forest plantation, as compared with only 10 to 15 using labour-saving equipment.

Industrial plants such as sawmills and pulp mills also provide some employment. However, it is becoming increasingly clear that the biggest and most dynamic source of employment in the whole forestry sector (including primary forestry operations) is in small-scale artisanal activities (for example carpentry, furniture-making, handicrafts and charcoal burning) at the household and workshop level. In many countries this is one of the most important sources of rural employment after farming, and merits much more study than it has received up to now.

Foreign exchange earnings

In view of the food import requirements of many developing countries, their foreign exchange earnings from the export of logs and processed forest products are a contribution to their access to adequate food supplies. However, very few of these countries now have a net export of forest products. Countries with such large forest resources as Nigeria have become net importers. The main emphasis at present is therefore on increased local processing, not only to raise the value-added component of export earnings but also to limit foreign exchange expenditure on imports of processed forest products. The total value of the developing producing countries' exports of tropical logs, sawnwood, veneer and plywood peaked at about US\$5 900 million in 1980 and then dropped sharply. The developing countries' imports of forest products (mostly pulp and paper) reached US\$8 700 million in 1981 and have since fallen slightly. Wood based fuels may also sometimes substitute imported fossil fuels.

Rural infrastructure

A minor, although sometimes locally important, contribution of forestry to food security is through the shared use with agriculture of forestry infrastructure and services. Forest roads can help to link remote agricultural settlements to markets, as has been particularly important in Belize and in the Amazon region of Brazil. However, it is necessary to ensure that the public use of forest roads does not lead to the illegal cutting of wood and to the haphazard clearing of forest land for agriculture. The development of forest industries often includes the provision of power lines and electrical generation, and these too can sometimes be shared with rural communities.

Fuelwood supplies

Fuelwood still represents more than half of the world's total output of wood, and about 85 percent of that used in the developing countries. It accounts for more than a fifth of the total energy consumption in these countries, and more than three quarters in the poorest of them.

It is the principal fuel used in the preservation and other processing of food in the rural areas of the developing countries, and thus contributes to the stability of food supplies through the year. Above all, however, as the predominant fuel used by poor people for cooking, it is essential in order to convert adequate food supplies into adequate diets. A few foods, such as some varieties of cassava, have to be cooked to make them safe for human consumption, and many other foods require cooking to increase their digestibility and palatability, and to reduce the danger of disease from parasites and other pathogens.

Fuelwood supplies have been rapidly depleted, and the cutting of fuelwood has in turn been a major cause of excessive deforestation. In many rural areas people (and especially women) now have to walk very long distances to collect and haul fuelwood, and often the frequency of cooked meals has had to be reduced. The shortage of fuelwood is an important contributory cause of malnutrition and disease in many areas.

FAO has estimated that in 1980 almost 100 million rural people in the developing countries were living in areas with an acute scarcity of fuelwood, a further 1 000 million where current levels of use could no longer be sustained, and another 300 million where there was a prospective deficit. By the year 2000, if past trends continued, as many as 2 400 million people would be in areas of acute scarcity or unsustainable levels of use (9).

This shortage of fuelwood had long been foreseen, but it was assumed that its use would rapidly be replaced by cheap supplies of kerosene and other oil-based fuels. However, these expectations were drastically altered with the first steep rise in oil prices in the early 1970s, since when maintaining and increasing fuelwood supplies has become an urgent priority.

Existing forest resources have to be managed more effectively, with much greater emphasis on fuelwood production. New plantations of quick-growing species must be established as rapidly as possible, either for multiple use or specifically to produce fuelwood. Small village-level community woodlots are of particular importance in this regard. The increased incorporation of trees in farming systems, as discussed below, can also add

to fuelwood supplies. More efficient methods and equipment are required for charcoal making and for wood-burning stoves and cooking utensils.

However, the dimensions of the fuelwood problem are so large that it is unlikely to be possible to do more than mitigate it. An acute shortage of fuel seems bound to continue in the rural areas of the developing countries until new alternative sources of cheap energy can be developed and made available on a large scale.

IV. TREES IN FARMING SYSTEMS

Up to now the discussion in this document has been almost entirely in terms of the macro-level contributions to food security of what may be described as "conventional forestry": that is to say, the areas (generally large units) that are officially classified as forests and are the responsibility of government forestry departments. Some of the same contributions to food security can, however, also be made by the greater use of forest and other trees at the micro-level of the farm. These will now be reviewed, together with some of the farming systems which combine the production of trees, field crops and livestock.

A bridge between these two levels is afforded by the recently introduced concept of "community forestry", which in fact includes the promotion of farming systems that incorporate the use of forest trees. It is bringing a much closer involvement of the forestry sector (and of professional foresters as well) in the poverty-oriented rural development that is essential for eventual world food security.

Contributions of trees to farming

Trees are often removed from agricultural land because they compete with crops, harbour pests, and impede monocropping and mechanization. Forest and other trees can, however, make an important contribution in increasing and maintaining the productivity of food production systems in situations that are now primarily agricultural rather than forest. This contribution includes fuelwood and other wood outputs required as inputs for food production, fodder for livestock, shade and protections from wind and water erosion, and the maintenance of soil fertility.

Increased tree planting in farm shelterbelts, along roads and canals and in small farm and village woodlots can significantly contribute to fuelwood supplies. Wood, bamboo and other forest products are also often the cheapest material for the construction or manufacture of a very wide range of inputs for farming, including barns, storehouses, racks for drying and storage, livestock pens, fencing, carts, wheelbarrows, tools and tool handles, stakes, and crates and baskets for the marketing of certain produce. All of these can be made locally provided the raw material is available.

A promising new approach to fodder production is the growing of high-yielding tree species in "fodder orchards". Certain leguminous species in particular yield foods that are very rich in protein. In some circumstances trees can produce more livestock food than cereals, for instance carobs in dry areas of north Africa. Some shrubs in Nepal can provide fodder even in the first year.

By screening neighbouring land from wind and by reducing air turbulence, trees affect conditions over an area whose depth is several times their own height. They reduce the rate of evaporation and enable crops and grass to achieve more growth for a given amount of water. The shelterbelt impact on soil erosion is very great, reducing both wind and water erosion. The shade and "nurse" function of trees is also important for both crops and livestock, especially in arid areas, through the interplanting of shade trees as well as windbreaks and shelterbelts.

As was noted earlier, trees can draw nutrients from much deeper soil layers than crop plants. Their leaf fall can be used as a natural mulch to increase soil moisture as well as fertility. As many as 600 different tree species (not only leguminous ones) are known to be able to fix atmospheric nitrogen. Thus it is estimated that in the humid tropics *Leucaena leucocephala* fixes an annual average of 500 kg of nitrogen per ha, and *Casuarina littoralis* 218 kg. The latter species also has fungal symbionts which metabolize phosphorus and other nutrients and slowly release them into the soil.

The most appropriate trees for incorporation into farming systems must of course be chosen in accordance with local conditions. However, a number of species, especially some quick-growing legumes, combine several of the desired characteristics, including the rapid production of a useful crop of wood, fodder production, deep roots and nitrogen fixation.

Integrated production systems

Increasing attention has recently been given to integrated farm production systems that include trees as well as crops and livestock, especially in particularly fragile situations such as upland watersheds where shifting cultivation is destroying forest cover, and arid areas in danger of desertification. This approach is now widely described as "agro-forestry". While intensive research on agro-forestry is fairly recent, the practice is not. There are many traditional such systems, including (if, as is normal, the concept is defined to cover sequential as well as spatial combinations) shifting cultivation itself (10).

Apart from shifting cultivation, the main sequential system is the taungya system, a type of agricultural afforestation involving the temporary cultivation of food crops in young tree plantations, which was started in Burma more than a century ago. However, because of the temporary nature of the agricultural phase, the farmer has to resettle at frequent intervals, and it is becoming less attractive.

More recently, therefore, attention has mainly been focussed on intercropping systems based on the spatial arrangement of the components of agro-forestry. These include border tree planting, alternate rows or strips, and random mixing. Border tree planting is gaining adherence because of the need for fuel wood, fodder and organic fertilizer. It also has the advantage of providing a much cheaper fence than cut poles and wire. Alternate rows or strips ("alley cropping") are particularly appropriate on sloping degradation-prone land, where the planting of contour hedgerows is almost as effective as terracing, which is far more costly. The random mixing of field crops, climbers, small fruit trees and larger trees such as coconut palms is typical of small-scale agricultural production in many parts of the developing world, although in some areas it is tending to be replaced by monocropping.

All of these systems can also include pasture and grazing, provided the latter is properly controlled, and especially if fodder trees are used. If sufficient fuelwood can be produced to meet the needs of the farm family, the animal dung need not be used for fuel and becomes available as additional organic manure.

Although agro-forestry is not the panacea that is sometimes suggested, it is a very promising area which can contribute to greater food security in many different ways. In addition to its environmental contributions, it can bring a much-needed diversification of farm production systems, leading to more stable and secure incomes and thus better access to food supplies. Trees can provide valuable cash crops in the form of fuelwood, fodder and other products.

Many research problems remain to be solved, especially concerning the most appropriate combinations (and there are numerous interactions and trade-offs to be considered) of trees, field crops and livestock in specific local conditions. The aim is to devise stable, sustainable systems that do not damage the environment and that maximize total productivity and income. Long-term security of land tenure is an essential ingredient. A massive extension effort is required in areas where there is no tradition of tree cultivation to convince small farmers that trees do not necessarily get in the way of their food production but instead can actually contribute to it in many ways, to teach them how to take advantage of these contributions, and to provide them with planting stock and other inputs. Forestry departments will inevitably have to be expanded in order to play this increasingly important role in helping scattered small farmers, as well as dealing with large but generally concentrated forest areas. However, not all these new tasks need necessarily fall solely on forestry departments, as is evidenced by the successful development of tree nurseries in India by schools and farmers and other private individuals.

V. CONCLUSIONS

This preliminary review of the contributions of forestry to world food security should leave no doubt that its actual and potential contributions are both numerous and crucial. They occur both at the macro level of the national forest area and at the micro level of the farm. Although the protective environmental role of forestry is of overwhelming importance, it also makes many other direct and indirect contributions to the adequacy and stability of food supplies and to access to them. The current acute shortage of fuelwood also seriously affects food production and food security.

The main purpose of this document is to increase awareness and to ensure that the role of forestry is given due consideration in discussions of world food security. At the same time, however, the CFS may already wish to consider some of the specific problems that clearly require urgent attention if both shorter and longer-term world food security are not to be still further endangered.

One of the most urgent problems concerns the upland watersheds where forests are being destroyed by shifting cultivation, and the need to develop sustainable farming systems for the people who inhabit them. Other problems of similar urgency include the arid areas in danger of desertification, the conservation of threatened forest ecosystems containing

irreplaceable genetic resources for future plant and animal breeding, and the improvement of fuelwood and other rural energy supplies.

There is much scope for closer collaboration between agricultural and forestry experts and departments in land use planning. It is increasingly necessary to recognize that agriculture and forestry are not competitive but interdependent uses of the land. It is essential, especially in Africa, to study and propose remedies for the harmful land use practices, leading to environmental degradation, that lie behind so many of the current food emergencies.

A specific area that merits further study in relation to food security is the contribution to rural employment and incomes of artisanal activities based on forestry. Their role in enabling better access to food supplies could be particularly important for the growing number of landless rural people in so many countries.

At the farm level, the recent growth of interest in agro-forestry can help to break down the legal and administrative barriers that have often developed between agriculture and forestry. It offers the opportunity for agricultural and forestry staffs to work together in innovative approaches to land use and in devising and promoting the stable, sustainable, diversified and highly productive systems that are an essential foundation for food security.

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